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NOTES ON GEOGRAPHIC DISTRIBUTION

New record of *Rhynobrissus cuneus* Cooke, 1957 (Echinoidea, Spatangoida) from the eastern Florida coast

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Abstract. The Brissidae is a family of heart urchins that includes shallow-water, infaunal species, some of which are rarely observed. One species, *Rhynobrissus cuneus* Cooke, 1957, has only been recorded from the western Atlantic off the coast of North Carolina, USA and in the Gulf of Mexico off the coast of Veracruz, Mexico. This work identifies new records from the coast of Florida, USA, increasing our knowledge of this species' geographic distribution.

Keywords. Atlantic, Brissidae, Caribbean, heart urchin, Irregularia

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INTRODUCTION

The Spatangoida (heart urchins and related forms) comprises the single most diverse clade of all extant sea urchins (Stockley et al. 2005). Although deep-sea, and particularly abyssal, heart urchins include taxa known to be epifaunal, the majority of the species are infaunal, sometimes burrowing into the sediment to depths many times that of the test height (Mortensen 1951; Nichols 1959). Among the most diverse families of Spatangoida, the Brissidae is made up of species that are generally shallow burrowers in fine to coarse sands of tropical to temperate inshore habitats. As such, brissids are more likely to be negatively affected by anthropogenic disturbances such as dredging or trawling (Hauton et al. 2003; RM personal observation).

Arguably among the most seldom encountered of brissid genera, *Rhynobrissus* A. Agassiz, 1872 has recently been suggested to include as many as six extant species in the World Echinoidea Database (Kroh and Mooi 2024). However, as correctly noted by Weaver et al. (2018), only four extant species are presently recognized (McNamara 1982; Martínez-Melo et al. 2014; Weaver et al. 2018). Of these, the type species, *Rhynobrissus pyramidalis* A. Agassiz, 1872, and *R. hemiasteroides* A. Agassiz, 1879 are Indo-Pacific. *Rhynobrissus tumulus* McNamara, 1982 is known only from the coast of Western Australia. A single species, *R. cuneus* Cooke, 1957, is restricted to the Atlantic Ocean off the southeastern coast of North America (Cooke 1957; Martínez-Melo et al. 2014; Weaver et al. 2018). All species are rarely seen, and little is known of their biology and full ranges. Therefore, any new records of these species are significant.

Rhynobrissus cuneus was previously known from only two localities in waters to the east of the Isthmus of Panama (Cooke 1957; Martínez-Melo et al. 2014; Weaver et al. 2018); one off North Carolina, USA from two sites, Buxton Beach and Ft. Macon Beach; and the other near Veracruz, Mexico (Figure 1). The large geographic distance between these two localities, combined with the paucity of subsequent collection records for this species, strongly suggest that *R. cuneus* is more widespread than has been recorded in the literature. Like many heart urchins, particularly brissids, this is a shallow-burrowing species seldom encountered on the surface of the substrate. It also has an extremely thin and fragile test. These factors make the animal difficult to survey and/or collect, particularly as entire tests, and especially as living specimens.

Recently, freshly exposed but denuded tests of *R. cuneus* were collected off the southeastern coast of Florida, USA. This discovery prompted a study of the area to find additional material, survey its occurrence and characterize habitats, and determine through local resources if this species has been noted previously along the Florida coastline.

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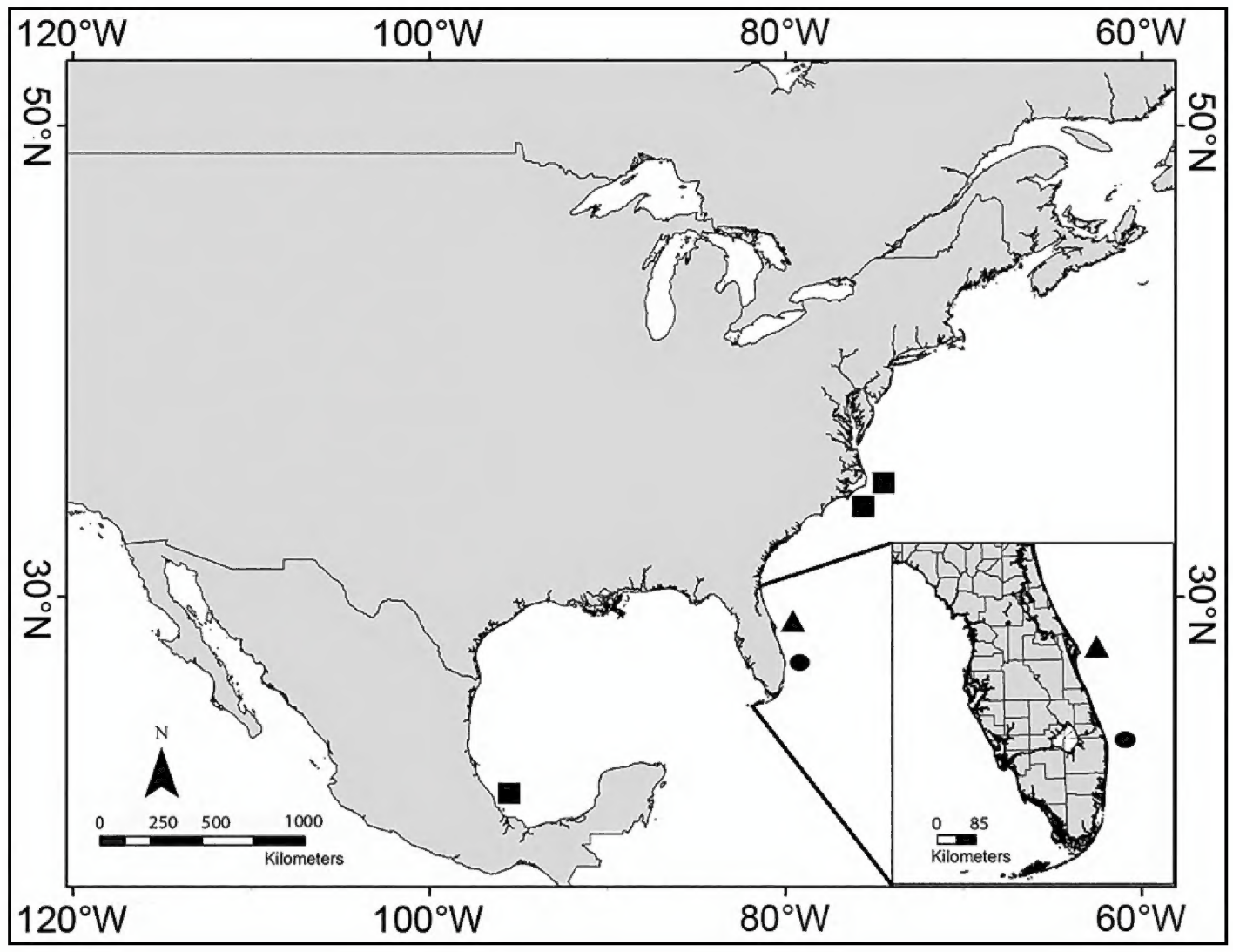

Figure 1. Map of sites where *Rhynobrissus cuneus* has been recorded. Solid squares indicate previously known localities along North Carolina, USA (1957, 2018) and Veracruz, Mexico (2014). Solid circle indicates survey site from this study, Palm Beach, FL. Triangle indicates sampling site from museum specimen records, Cape Canaveral, FL (collected by P. Baker 2014–2019, unpublished).

METHODS

To determine and study local occurrences of *Rhynobrisssus cuneus*, three sampling surveys were conducted from July to August 2024 off Palm Beach Island, Palm Beach, Florida, USA (Figure 1). The initial survey consisted of a visual 100 m × 100 m free diving search area followed by two down-current drift snorkels of lengths of 200 m and 800 m. Specimens were located subtidally on the surface of fine sand substrate approximately 200 m from the shoreline and 10–20 m shoreward from the first nearshore hardbottom reef line at a depth of 4–5 m. Tests from recently deceased specimens were collected via free diving and were brought to shore by hand or in a cushioned container. The collected tests were gently rinsed with fresh water and air dried. Collected specimens were maintained as vouchers in the Invertebrate Collection, Department of Biology, Palm Beach Atlantic University, West Palm Beach, FL, USA, and in the Invertebrate Zoology Collection, California Academy of Sciences, San Francisco, CA, USA.

All specimens were identified visually using morphological characteristics provided in original descriptions and imagery in the available literature (Cooke 1957; Martínez-Melo et al. 2014; Weaver et al. 2018). Higher classification is that in Kroh and Mooi (2024).

RESULTS

Class Echinoidea Schumacher, 1817
Order Spatangoida L. Agassiz, 1840
Family Brissidae Gray, 1855
Genus *Rhynobrissus* Agassiz, 1872

Rhynobrissus cuneus Cooke, 1957

Figure 2

New records. UNITED STATES OF AMERICA / ATLANTIC OCEAN – **Florida** • Palm Beach County, Town of Palm Beach; 26°42′01″N, 080°01′51″W; 4–5 m depth; 28 Jul. 2024 to 8 Aug. 2024; Angela D. Witmer leg.; 10 individuals, included 8 collected; IC2024-01, IC2024-02, CASIZ 236857, CASIZ 236858, CASIZ 236859, CASIZ 236860, CASIZ 236861.

Identification. The combined presence of peripetalous (Figure 2A) and well-developed subanal fascioles (Figure 2B, C), along with the absence of a frontal notch, indicate that the recently collected specimens from Palm Beach are members of the family Brissidae. Within the family, *Rhynobrissus* is characterized by paired posterior interambulacral plate columns that do not reach the peristomial edge, strongly developed anal fascioles that almost encircle the periproct, and a slightly keeled sternum. These features strongly

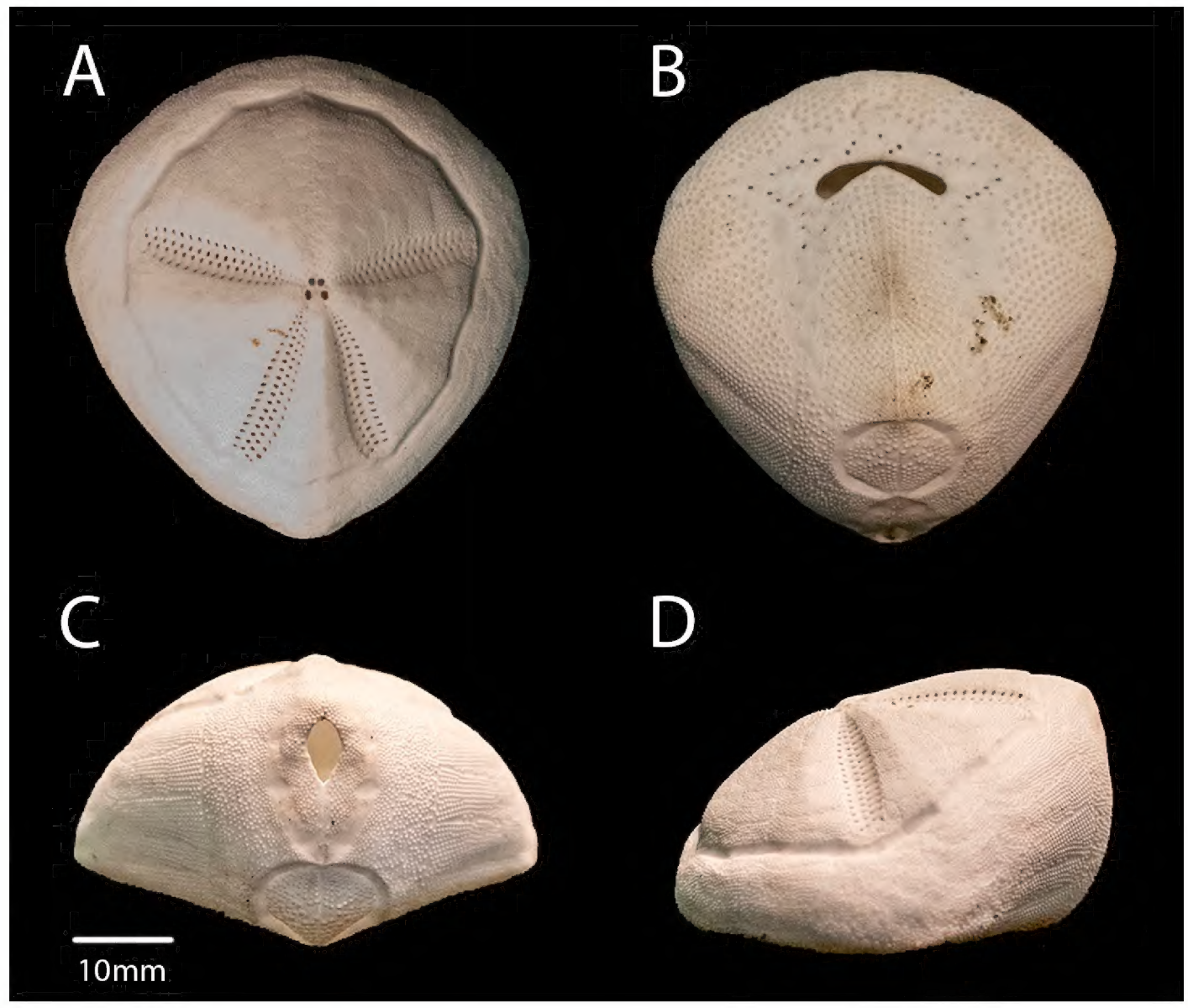

Figure 2. Photographs of *Rhynobrissus cuneus*. **A.** Aboral (top) view showing peripetalous fasciole. **B.** Oral (bottom), slightly oblique view with posterior tilted toward the viewer, showing subanal and associated anal fascioles. **C.** Posterior view showing subanal and associated anal fascioles. **D.** Left side view.

support placement of the Palm Beach material in that genus. McNamara (1982) indicated that tube foot pores were absent within the subanal fasciole, but this is incorrect. Examination of a specimen of the type species of the genus, *R. pyramidalis*, shows that there is at least one pore from each posterior paired ambulacrum within this fasciole, a configuration shared not only with our specimens, but with the holotype of *R. cuneus* and the specimen figured by Weaver et al. (2018: fig. 1G).

Rhynobrissus cuneus has been described and figured several additional times since the original description and illustrations provided by Cooke (1957), particularly by Martínez-Melo et al. (2014) and Weaver et al. (2018), both of whom were able to provide additional details of test morphology and spination. Imagery in these papers is also of high quality, permitting necessary comparisons with our material, and obviating the need for additional description. In addition, McNamara (1982) provided a key to all the known extant species, and our specimens key out to *R. cuneus*, the only species of *Rhynobrissus* known off the North American coast. The most definitive feature of *R. cuneus* is the sharp drop in test height anteriorly from the apex to the ambitus, giving the test a conspicuous wedge-shaped profile (Figure 2D). It is this feature, so conspicuous in our material as well, for which the species was named (*cuneus* being Latin for "wedge").

Remarks. During this survey 10 individuals were observed, and eight collected and identified as *R. cuneus* through direct observations (Table 1). Twenty-two additional specimens were accessed through museum

Table 1. List of *Rhynobrissus cuneus* specimens found off Palm Beach Island, eastern coast of Florida and deposited into collections at Palm Beach Atlantic University (PB) and the California Academy of Sciences, Invertebrate Zoology (CASIZ).

Date	Length (mm)	Width (mm)	Height (mm)	Depth (m)	Catalog number
28 Jul 2024	40	38	24	4	PB IC2024-01
28 Jul 2024	40	41	26	4	PB IC2024-01
7 Aug 2024	40	41	24	4.5	PB IC2024-02
7 Aug 2024	40	39	24	5	CASIZ 236857
7 Aug 2024	38	37	23	5	CASIZ 236858
7 Aug 2024	39	38	23	5	CASIZ 236859
8 Aug 2024	41	40	24	4.5	CASIZ 236860
8 Aug 2024	38	37	23	4.5	CASIZ 236861

specimen records at the University of Florida Invertebrate Zoology Collection, Florida Museum of Natural History (FLMNH), Gainesville, Florida, USA (FLMNH 22174, 22182, 22183, 22185-22199, 22205–22207). The museum specimens were collected from 2014 to 2019 7.5–13 km off Cape Canaveral, Brevard County, Florida, USA (Figure 1). Additional reviews of local resources and species lists from county agencies (Palm Beach County Environmental Resources Management), state parks (John D. MacArthur Beach State Park and Florida Department of Environmental Protection), and Florida state/federal entities (Florida Department of Environmental Protection, Florida Sea Grant, and Smithsonian Marine Station, Ft. Pierce) found this species was not included.

DISCUSSION

This work, along with that in previously published accounts, increases the number of known individuals with most in repositories to 81. These repositories include: National Museum of Natural History, Smithsonian, Washington, DC (collected in the 1950s in North Carolina, reported in Cooke 1957); Mississippi Museum of Natural Science, Jackson, MS (collected in 2017 in North Carolina, reported in Weaver et al 2018); North Carolina Museum of Natural Science, Raleigh, NC (collected in 2018 in North Carolina); Institute of Marine Sciences and Limnology, National Autonomous University of Mexico, Mexico City, MX (collected in 2014 in Veracruz, reported in Martínez-Melo et al. 2014); University of Florida Invertebrate Collection, Florida Museum of Natural History, Gainesville, FL (collected between 2014 and 2019 in Florida); Palm Beach Atlantic University Invertebrate Collection, West Palm Beach, FL (collected in 2024 in Florida, reported herein); California Academy of Sciences, San Francisco (collected in 2024 in Florida, reported herein) (Table 2).

This work partially fills a gap in the species' distribution from North Carolina, USA through Eastern Florida, to the Gulf of Mexico, Veracruz, Mexico. The patchy distribution is highly likely a product of infrequency with which the animal's thin test survives wave action, and in the low intensity of collecting in the environments in which *R. cuneus* lives. The species is infaunal in fine sand sediments (Martínez-Melo et al. 2014) and is easily overlooked during visual seafloor surveys. Previously, specimens were identified from freshly dead tests either washing ashore (Cooke 1957; Weaver et al. 2018) or exposed and rolling along the seafloor in shallow water near the wave base. *Rhynobrissus cuneus* is found as jetsam specimens in North Carolina, along the Florida shoreline at depths of 4–15 m, and as shallow as 1 m (Martínez-Melo et al. 2014). These observations support the finding that *R. cuneus* lives in shallow enough water, and not deeply enough buried to escape being washed ashore by storm and wave action, or by exhumation during dredging to support nearby beach nourishment projects (Weaver et al. 2018).

Offshore population sizes are as yet unknown because many surveys are incomplete, have found fewer than 10 specimens at a given location (Cooke 1957; Martínez-Melo et al. 2014). Weaver et al. (2018) found more but these were likely time-averaged accumulations of beaching events. It is safe to assume that

Table 2. List of known *Rhynobrissus cuneus* specimens, 1955–2024.

Collector	Count	Collection year	Collection location	Museum collection	Resource
M Downey	1	1955	Fort Macon Beach, NC, USA	National Museum of Natural History, Washington, DC, USA	USNM catalog
M Downey	7	1956	Fort Macon Beach, NC, USA	National Museum of Natural History, Washington, DC, USA	Cooke 1957
C Laughing-house	2		Fort Macon Beach and Shackleford Beach, NC, USA	National Museum of Natural History, Washington, DC, USA	USNM catalog
EM Sadorf	7	2017	Buxton Beach, NC, USA	Mississippi Museum of Natural Science, Jackson, MS, USA	Weaver et al. 2018
EM Sadorf	12	2017	Buxton Beach, NC, USA	North Carolina Museum of Natural Science, Raleigh, NC, USA	Weaver et al. 2018
Martínez-Melo et al.	7	2014	Playa Jicacal, Los Tuxtlas, Veracruz, MX	Institute of Marine Sciences and Limnology, National Autonomous University of Mexico, Mexico City, MX	Martínez-Melo et al. 2014
FV De la Cruz	12	2013	Los Pinos, Veracruz, MX	Facultad de Ciencias Biológicas y Agropecuarias, Universidad Veracruzana, Región Poza Rica-Tuxpan, MX	González-Gándara 2024
FJ Gomez Marin	1	2005	Los Tuxtlas, Veracruz, MX	Unknown	iNaturalist 2024
P Baker	22	2014–2019	Cape Canaveral, FL, USA	Florida Museum of Natural History, Gainesville, FL, USA	G. Paulay, FLMNH
AD Witmer	5	2024	Palm Beach, FL, USA	Palm Beach Atlantic University, West Palm Beach, FL, USA	Reported herein
AD Witmer	3	2024	Palm Beach, FL, USA	California Academy of Sciences, San Francisco CA, USA	Reported herein
AD Witmer	2	2024	Palm Beach, FL, USA	Not curated; field observations only	Reported herein

fragility of the tests greatly reduces the number of specimens that are washed ashore, and that estimates of the sizes of offshore populations will not be accurately represented by these rare events. Due to their sensitivity to alterations in particle size range, oxygen levels, and food availability, species such as *R. cuneus* are "canaries in the coal mine" that indicate anthropogenic change due to factors such as dredging, pollution, and global climate change. Therefore, more directed research on this species to determine habitat, depth, and population sizes is necessary to determine how viable it will remain off our coasts and to provide data on environmental disturbances likely to affect many other denizens of the unique ecosystem represented by offshore sand beds.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: ADW, RM. Data curation: ADW. Formal analysis: ADW. Investigation: ADW. Methodology: ADW. Resources: ADW, RM. Supervision: ADW. Visualization: ADW. Project administration: ADW. Validation: RM. Writing - original draft: ADW, RM. Writing - review and editing: ADW, RM.

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Data availability

All data that support the findings of this study are available in the main text.

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